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AEC ATOMIC WEAPON DATA

HISTORY OF THE MK 55 WARHEAD (U)

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Weapon Systems

Information Research Division, 3434

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Mk 55 Warhead - Cross Section

Timetable of Mk 55 Events

9/19/56	Assistant Secretary of Defense requests Atomic Energy Commission to cooperate with the Navy in a feasibility study of a nuclear warhead for a submarine-launched torpedo. Study conducted throughout 1957 recommended development of SUBROC, a rocket-propelled torpedo for attack of enemy submarines.
1/17/58	Bureau of Ordnance requests cooperation of the Atomic Energy Commission in feasibility study of warhead for SUBROC.
1/22/58	Special Weapons Development Board urges support of SUBROC warhead.

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1/6/59	Assistant Secretary of Defense requests Atomic Energy Commission to develop SUBROC warhead.
2/17/59	Military Liaison Committee releases set of military characteristics for SUBROC warhead.
4/17/59	Designation of XW-55 assigned to SUBROC warhead.
8/31/59	Sandia forwards development program definition of XW-55 Warhead to Albuquerque Operations Office.
10/61	Sandia releases proposed ordnance characteristics of XW-55 Warhead.

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3/20/63	Mk 55 Warhead design released.
1/64	Mk 55 Warhead achieves production.
7/23/64	Final development report of Mk 55 Warhead accepted by the Design Review and Acceptance Group.

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History of the Mk 55 Warhead

By the fall of 1956, design was in progress on the Mk 44 depth-bomb warhead, designed for surface-ship attack of enemy submarines. Subsequently, the possibility of developing a warhead that could be launched from one submarine against another was raised and, September 19, 1956, the Assistant Secretary of Defense requested the United States Atomic Energy Commission to cooperate with the Navy in a feasibility study of a nuclear warhead for such a submarine-launched torpedo.[1]

This study was conducted during 1957. The missile was called SUBROC, and was a rocket-propelled missile launched into the atmosphere from a submerged attacking submarine and designed to attack a target submarine located underwater at some distance.

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In response to a teletype from the Division of Military Application, Sandia noted, December 26, 1957, that warheads could be supplied by March 1960. However, complete design release could not be made until flight tests had provided adequate proof of warhead and missile system compatibility. These flight tests would start in the fall of 1959 and continue into 1960. It was felt that the design might be released by December 1959, and that production warheads would be available by October 1960.

Warheads for the first two submarines would be produced in accordance with design information available in August 1959. These units would not be of full production quality since flight test data would not be available, although much of the critical laboratory testing would have been completed.

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The Special Weapons Development Board met January 22, 1958 and listened to a presentation on the proposed SUBROC weapon. It was pointed out that the United States was committed to the economic and military support of the 15 member nations of the North Atlantic Treaty Organization (NATO), located on four continents. Since this support required maintenance of seaborne and logistic links, the collective security of NATO could be seriously jeopardized by an aggressive enemy submarine campaign. There was thus an urgent need for an effective anti-submarine warfare (ASW) weapon system.

Submarines appeared to be the most suitable delivery vehicles for such weapons, but available submarine-launched weapons had only limited effectiveness. Torpedos were reasonably efficient only to a range of about 10,000 yards (less than 6 miles). High-speed torpedos were noisy and alerted their targets. Long-range, quiet torpedos required command inputs during travel to target, and were relatively slow. It was felt that a SUBROC-type missile would greatly enhance the ASW capabilities of the Navy's submarines.[4]

Meanwhile, the Bureau of Ordnance, in a letter dated January 17, 1958, noted that the SUBROC study had been completed and requested the cooperation of the United States Atomic Energy Commission in a feasibility study of a suitable warhead.

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(b)(1), (b)(3) The outside diameter would be 13 inches, length 42-1/8 inches, and weight 370 pounds. Reasonable variations in these parameters would be acceptable in order to develop an optimum missile/warhead combination.

(b)(3)

The Division of Military Application, in forwarding the military characteristics, referred to the moratorium on nuclear testing. If dimensional limitations could not be satisfied without further testing, the Military Liaison Committee would be informed concerning those parameters that could be provided without such testing.[9]

Development was authorized for the SUBROC warhead application March 24, 1959, and Sandia notified Albuquerque Operations Office April 17, 1959 that the designator XW-55 had been assigned to the program.[10] Plans were made for air-gun and drop-tests to certify the structural adequacy of the warhead for water entry. A relatively small number of flight tests would be required, and full-scale firings would be made in early 1960.[11]

Sandia forwarded the development program definition on the XW-55 Warhead to Albuquerque Operations Office August 31, 1959. The warhead would fulfill requirements for a 450-pound warhead for the SUBROC missile. The military characteristics had specified a warhead weight of 370 pounds, but it was found that missile stability required that additional weight be placed as far forward in the missile as possible, and the Bureau of Ordnance requested that a suitable change be made to the military characteristics.

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The design would be released in mid-1962, and early production was scheduled for the second quarter of calendar 1963. The warhead would be operational by July 1963.

The warhead would have a maximum diameter of 13 inches and maximum length of 39.4 inches.

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The firing system would include a chopper-converter, capacitor-type X-unit, and acceleration-sensing handling safety devices. The warhead would be sealed and would require only continuity monitoring in stockpile or field.

The SUBROC was designed to be fired from a Navy standard 21-inch-diameter torpedo tube. The missile would have a maximum diameter of 21 inches, length of 246 inches, gross weight of 4000 pounds, re-entry depth-bomb weight of 900 pounds, and a range from 5 to 35 nautical miles. Velocity at water impact at the maximum range would be about 1500 feet per second and the missile would have a solid-fuel propulsion system.

Due to high-load-factor requirements, the case would be built of high-strength steel having a yield point of about 160,000 pounds per square inch.

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The military characteristics were amended by the Military Liaison Committee November 12, 1959. The weight of the warhead without frangible nose section was increased to 450 pounds, including ballast if necessary. The warhead would be compatible with such other applications (in addition to the SUBROC) as might be authorized by the Department of Defense.[13]

By April 1960 it had been decided that a g-second environmental sensing device would provide maximum warhead safety. Although the weapon was being designed specifically as an underwater-launched air-trajectory missile for depth-charge application, it was felt that the warhead should also have a capability for air-burst detonation, or operation independent of the water-entry environment. Thus, an environmental sensing device actuated by launch environment was desired. Devices currently available did not meet SUBROC requirements, with its relatively low launch acceleration.[14]

Sandia published Report SC4818(WD), XW-55 Warhead, Proposed Ordnance Characteristics, in October 1961.

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The report had been previously reviewed by the Design Review and Acceptance Group and found to be satisfactory with the exception of monitoring provisions.

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The report noted that design release was slated to start in January 1962 and to be completed during June 1962.

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The trajectory would be

guided during both boosted and unboosted phases.

(b)(1), (b)(3) Upon re-entering the water, the missile would sink to a preset depth and detonate.

The missile weighed about 4200 pounds, including a 3300-pound motor section. The depth-bomb section contained a warhead, adaption kit, auxiliary power unit, and guidance and control system. The control system used fins to guide the missile after the depth bomb separated from the rocket motor. To provide enough fin area, the diameter of the depth bomb was restricted to 13 inches. The depth-bomb section weighed about 900 pounds. An aerodynamic nose fairing, attached to the front of the ballistic case, would be wiped off at water entry, exposing a flat nose which provided underwater stability.

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Shock tests simulating water entry at 1420 feet per second were reported November 13, 1961. Results demonstrated that the weapon case could withstand this shock without damage.[16]

Field Command notified Sandia, November 22, 1961, that the proposed ordnance characteristics had been reviewed with representatives of the interested Services.

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However, this deviation was temporarily accepted, pending results of further tests. There was also a requirement for physical separation of a vital component from the warhead. Inasmuch as the design included multiple safety devices, the Navy felt that the intent of the requirement had been met. It was noted that

radiation from the warhead should not be more than 0.1 Rem per week, but this figure had been exceeded, and the Navy was requested to restudy the requirement. The design was meanwhile considered acceptable to the Department of Defense.[17]

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The Lawrence Radiation Laboratory notified the Division of Military Application June 9, 1962 that the XW-55 Warhead, while in storage, emitted gamma-ray and neutron radiation in an amount somewhat greater than allowed by the military characteristics. The Naval Ordnance Laboratory suggested that shielding, as well as a security cover, be placed on each warhead. This added structure would weigh about 400 pounds, and it would be necessary to repeat an extensive series of vibration and shock tests, and possibly redesign the warhead.

Since the radiation level decreased rapidly with distance from the warheads, it was felt that only the warheads adjacent to the passageway would contribute significantly to radiation in the passageway, and it was recommended that the passageway be provided with appropriate shields, or that no warheads be stored next to the passageway.[19]

The warhead was tested on a hydraulic centrifuge in the launch orientation to a linear acceleration of 10 g's, and no structural damage was noted.[20] A shock test was reported September 21, 1962, which simulated the environment of a depth-charge attack made on a submarine carrying the XW-55 Warhead. Again, no damage was noted.[21] Other successful tests included roll acceleration, shipping vibration, dynamic heating, thermal cycling and shock, vibration of warhead and missile, electrical system, simulated water entry, hydrostatic, bottom impact and depth-charge shock, and cookoff tests.[22]

By July 1962 it was learned that the operational availability date of the SUBROC missile had been postponed from November 1963 to April 1964.[23] Accordingly, early production of the XW-55 Warhead was deferred to January 1964.

The Mk 55 Warhead was design released March 20, 1963.

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Field Command notified Sandia April 30, 1963 that Report SC4854(WD), Mk 55 Mod 0 Interim Development Report, had been reviewed in coordination with representatives of the Services.

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It was considered that the design was acceptable to the Department of Defense.[25]

The Mk 55 Mod 0 Directive Schedule was published July 31, 1963, and authorized quantity production and stockpiling. Early production of the warhead was achieved in January 1964.[26] In accordance with a request from the Department of Defense, the warhead weight was ballasted to 465 pounds rather than 450 pounds. The overall length of the warhead without frangible nose section was 39.283 inches, instead of the specified 39 inches.

Report SCL-WD-64-28, Mk 55 Mod 0 Final Development Report, was presented to and accepted by the Design Review and Acceptance Group July 23, 1964.

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Division of Military Application -- An AEC office that functions as liaison between the Military and weapons designers and producers.

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Field Command -- The local office of the Armed Forces Special Weapons Project, located on Sandia Base, Albuquerque, New Mexico.

Firing System -- The electrical system of the weapon that produces and applies a high-voltage current to the detonators.

Frangible -- Breakable.

g -- Force equal to one unit gravity.

Gas Boosting - The technique of increasing the yield of a nuclear device by introducing deuterium-tritium gas into the implosion process to increase the fission activity.

Hardtack -- A nuclear series of 72 tests. Hardtack I was held at the Pacific Proving Grounds from April 28 to August 18, 1958. The decision to declare a moratorium on testing resulted in Hardtack II, held at the Nevada Test Site between September 12 and October 30, 1958.

Implosion -- The effect created when a sphere of high explosive is detonated on its exterior surface. If suitable lens charges are provided to invert the explosion, the force of the shock wave is directed largely toward the center of the sphere.

Inertial Switch -- A switch containing a small weight and a spring. When subjected to an external force of acceleration or deceleration, the weight compresses the spring. Generally, a metering device is added to measure the length of time the external force is applied.

Kiloton -- A means of measuring the yield of an atomic device by comparing its output with the effect of an explosion of TNT. A 1-kiloton yield is quivalent to the detonation effect of 1000 tons of high explosive.

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Military Characteristics -- The attributes of a weapon that are desired by the Military.

Military Liaison Committee -- A Department of Defense committee established by the Atomic Energy Act to advise and consult with the AEC on all matters relating to military applications of atomic energy.

Millisecond -- One thousandth of a second.

Monel -- An alloy of nickel, copper and other elements, chiefly iron and manganese, in certain proportions.

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One-Point-Safe Weapon -- A weapon that will not produce a nuclear yield when detonated at one point on the surface of the high explosive.

Operation Hardtack -- See Hardtack.

Operation Nougat -- See Nougat.

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5.

6. (b)(3)

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24. (b)(3)

25. SRD Ltr, RS 3446/61653, Field Command to Sandia-Livermore, dtd 4/30/63, subject, Status of the Mk 55 Mod 0 Warhead at Complete Design Release. SC Central Technical Files, 55 Program, 2-4 through 2-18.

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27. (b)(1), (b)(3)